United States Patent

Velie et al.

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[45] **Jan. 25, 1972**

[54] OPPOSED VORTEX COMBUSTION CHAMBER

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[73] Assignee: **North American Rockwell Corporation**

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[52] **U.S. Cl.** **431/351**, 431/265

[51] **Int. Cl.** **F23d 15/00**

[58] **Field of Search** 431/265, 351, 352

[56] **References Cited**

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[57] **ABSTRACT**

A combustion chamber for burning fuel oil or the like consists of a tubular housing wherein a source of air is introduced axially along the interior walls of the chamber, the air being directed by baffles inwardly in two streams which flow in opposite circumferential directions. The counter rotating vortices intersect each other within the chamber. Fuel is introduced at some point along or near the dividing line of the vortices for uniform fuel-air mixing thereby enhancing the combustion properties of the mixture.

6 Claims, 4 Drawing Figures

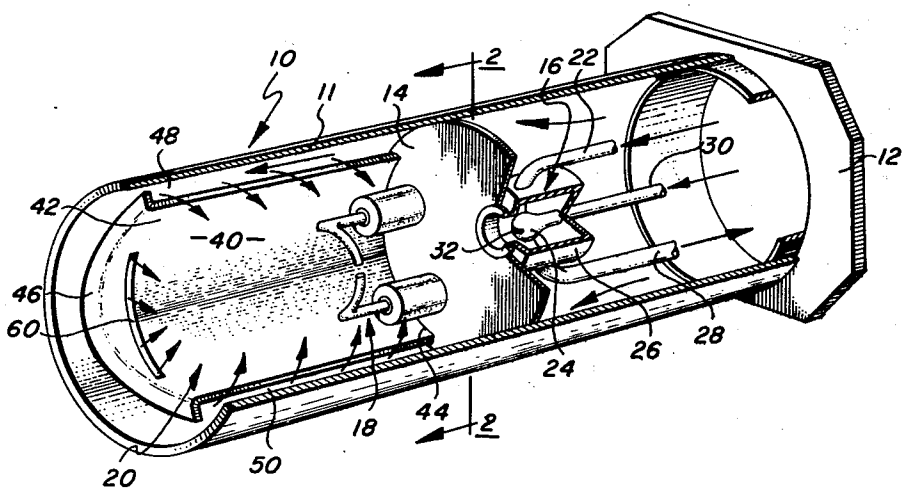
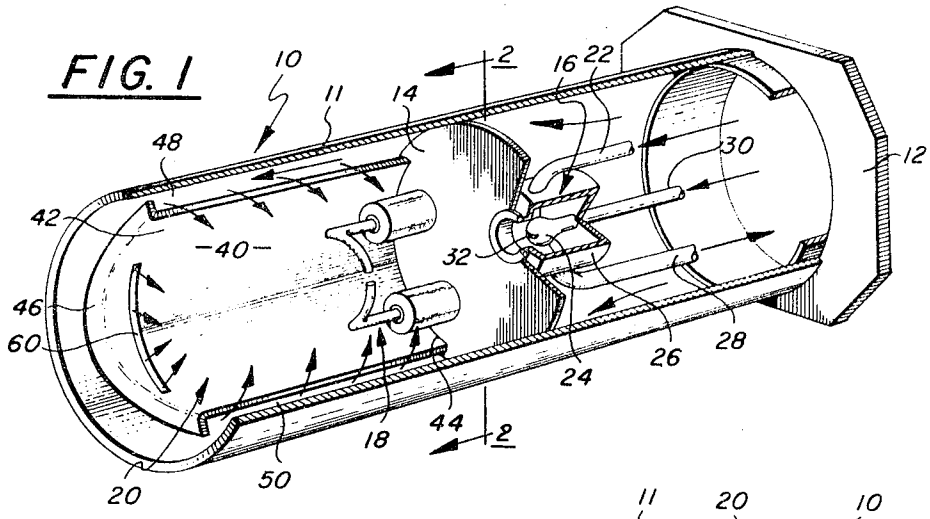


FIG. 1



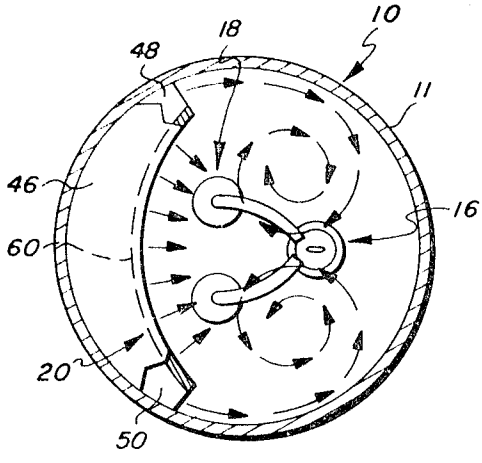


FIG. 3

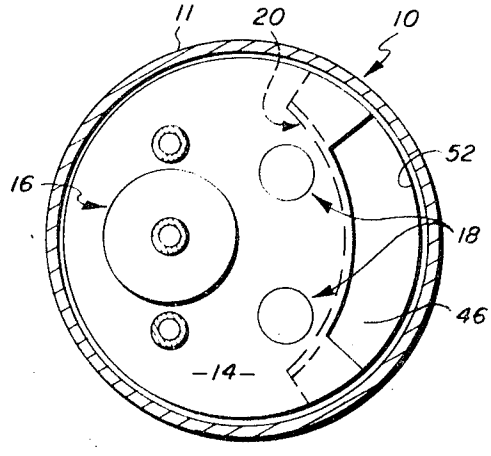


FIG. 2

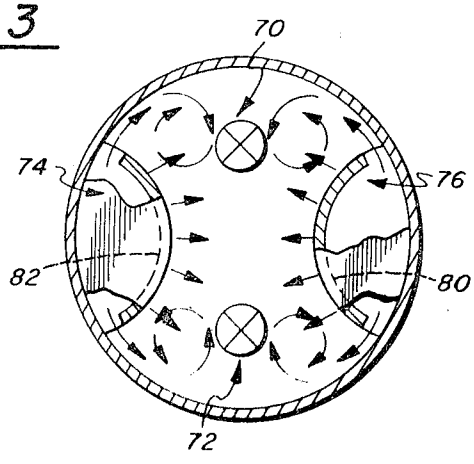


FIG. 4

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OPPOSED VORTEX COMBUSTION CHAMBER

BACKGROUND OF THE INVENTION

Conventional fuel furnaces used in, for example a domestic environment, use some mechanism of fuel-air mixing for efficient combustion within the burner or combustion chamber. A number of fuel-air mixing designs are known in the prior art. Most fuel oil burners utilize a single circumferential vortex generator to induce fuel-air mixing. However, when utilizing the foregoing mechanism, the air mass accumulates at the periphery of the burner head while fuel is introduced near the center, consequently a large mass of air is required to provide enough oxygen for proper burning. A good indication of how well the fuel-air mixture is consumed or burned is the residue from the combustion process, i.e., the smoke and soot generated therefrom. Obviously, the more desirable process would be the process which produces the least amount of smoke or soot which means, in essence, all of the fuel injected into the combustion chamber is consumed.

Conventional state of the art fuel burners generate a certain amount of smoke and soot largely due to relatively poor combustion of the fuel resulting from a nonuniform mixture of air and fuel.

Therefore, it is an object of this invention to provide a fuel oil burner which provides a uniform mixture of fuel and air.

More specifically, it is an object of this invention to provide a fuel oil burner which includes a secondary source of air introduced into the combustion chamber in oppositely rotating vortices which converge or impinge at a point the introduction of a primary fuel-air mass thereby encouraging a uniform mixture of the fuel oil with the air prior to ignition for more complete combustion of the atomized liquid.

SUMMARY OF THE INVENTION

Briefly, in accordance with one form of the invention, an improved fuel combustor is proposed wherein more complete mixing of the air and the fuel is provided whereupon when ignition occurs, the mixture is completely consumed thereby producing virtually no residue, i.e., smoke and soot.

The combustion chamber consists basically of a tubular section having at one end, a burner element or atomizer whereby the fuel is injected by a primary source of air into the chamber downstream of the burner assembly while at the same time introducing a secondary source of air axially along the interior wall of the tubular chamber.

The burner element or fuel atomizing device may be that shown in U.S. Pat. No. 3,425,058 which is subsequently briefly described relative to FIG. 1 of the present invention. The atomizer disperses the fuel in a very fine uniform droplet size, in a relatively narrow "cone." In order to provide a uniform mixture of air and fuel droplets, an effective means is needed to disperse the "cone" produced by the atomizer. An effective means to penetrate the "cone" for uniform mixing is a baffle which is partially concentric with the combustion chamber being spaced from the interior wall of the chamber thereby forming an annulus for directing the secondary source of air. A radially outwardly extending end plate at the downstream end of the baffle closes off the space defined by the baffle and the interior wall of the tubular section downstream of the atomizer element. A secondary source of air is introduced between the baffle and the inner wall of the combustion chamber so that the air axially traverses the wall of the chamber, strikes the end plate of the baffle and enters the combustion chamber from both open sides of the baffle tangentially thereby creating a pair of counterrotating air masses. The counterrotating vortices of the secondary mass of air impinge or intersect the "cone" of finely atomized droplets of fuel emanating from the fuel atomizer thereby uniformally mixing the fluid for ignition. A radially oriented slot near the closed end of the baffle downstream of the counterrotating air masses is provided to cause a jet or fan of air radially across the end of the combustion zone to create a kind of barrier or pneumatic restriction to partially confine the turbulent air masses thereby further ensuring a uniform combustion of the mixture of air and fuel. A conventional source of ignition such as arcing electrodes subsequently ignites the thoroughly mixed fluids.

An advantage over the prior art is the concentration of at least a pair of longitudinally extending counterrotating masses of air near the "cone" of injected atomized liquid in the chamber thus ensuring the proper mixture of air and the fuel oil resulting in a completely combusted product which more economically consumes the fuel.

DESCRIPTION OF THE DRAWINGS

The above noted objects and further advantages of the present invention will be more fully understood upon the study of the following detailed description in conjunction with the detailed drawings in which:

FIG. **1** is a partially cutaway perspective view of the preferred embodiment of the invention including all of the essential elements thereof;

FIG. **2** is a section taken along lines **2—2** of FIG. **1** illustrating the entrance channel of the secondary source of air;

FIG. **3** is a semischematic view of the two vortices formed by the baffle structure of the preferred embodiment, and,

FIG. **4** is another embodiment shown schematically of a combination of vortices and baffles within a burner assembly.

Referring now to FIG. **1**, a tubular or gun burner assembly or combustion chamber generally designated as **10** is mounted within a conventional furnace (not shown) at end plate **12**. The combustion chamber **10** consists of a tubular housing **11** having therein, a radially extending plate **14** which acts which acts as a basic mounting bulkhead for the fuel atomizing assembly **16**, igniter assembly **18** and the concentric baffle assembly generally designated as **20**.

The fuel atomizing assembly briefly described, admits liquid, for example fuel oil, through conduit **22** which gravitationally flows over the sphere **24**. The overflow liquid is collected in the bottom of housing **26** and is recirculated back to the liquid supply source (not shown) through conduit **28**. A primary source of air under higher than ambient pressure (not shown) is introduced through conduit **30** which exits through slot **32** in sphere **24**. The resultant passage of air through the slot atomizes the liquid which is stretched over the end of sphere **24** ejecting the mixture in a finely atomized narrow "cone" of droplets (previously described) within a combustion zone **40** downstream of the aperture in support wall or bulkhead **14**. The finely atomized mixture of the fuel oil or the like is then ignited by ignition source **18**.

The baffle assembly **20** primarily functions to enhance the combustion properties of the atomized liquid after it is injected through apparatus **16**. Baffle assembly **20** consists of a semicircular plate **42** and is fixed at its base **44** to bulkhead **14**. The downstream end of the plate **42** is closed off by a radially outwardly extending end plate or skirt **46** which is attached to the interior wall of the housing **11** thereby closing off the annular space between the baffle plate assembly **20** and the interior of the housing **11**. Preferably, as shown, the end plate is curved so as to enhance smoother flow and direct the flow in the annulus formed between the baffle and housing wall. The baffle assembly **20** defines at least a pair of axially extending openings or slots **48** and **50** thereby permitting a secondary source of air (not shown) to flow tangentially from both of these openings.

The opposed tangential entry of secondary air in a direction transverse to the axis of the tubular chamber out of each opening **48** and **50** of the baffle **20** performs two functions. First, the air directed along the curved wall of the chamber cools the chamber walls providing a "buffer" zone keeping the heat away from the walls and secondly, the opposing force of the two streams being directed by the curved wall meet opposite the baffle creating a pair of longitudinally extending counterrotating vortices which effectively and uniformally mix the relatively narrow "cone" of droplets emanating from the

atomizer when the atomizing element is located adjacent the intersecting line of the two vortices.

Referring to FIG. 2, an entrance opening 52 in plate 14 is shown for the introduction of a secondary source of air. The air enters through opening 52 into the annular space defined by the baffle assembly 20 and the interior of housing 11. The air enters axially, some flows through slots 48 and 50, the remainder strikes end closure plate 46 and escapes through radial opening(s) 60 or is recirculated. The tangentially directed secondary air mass escaping through openings 48 and 50 in opposite directions creates a pair of vortices which meet in combustion zone 40. The converging counterrotating vortices impinges with the atomized "cone" of liquid ejected through assembly 16 lengthwise thereof thereby further mixing the combustible mass. After the igniter device 18 is activated, a more complete combustion of the atomized liquid is insured resulting in a relatively smokeless combustion of the fuel. To further encourage mixing of the fuel and air, a radially extending slot 60 located near the end closure plate 46 of the assembly 20, emits a fan of air radially inwardly extending across the end of the combustion zone designated as 40. A pneumatic restriction of the turbulent airflow is provided thereby partially confining the mass within the combustion zone of the burner assembly 10.

The baffle device 20 including the radial slot 60 so directs and confines the secondary flow of air entering through opening 52 and out through slots 48 and 50, (as clearly shown in FIG. 3) to more thoroughly mix the primary atomized fuel-air mass for complete combustion. The baffle assembly 20 is designed with restricted openings 48 and 50 accelerate the air masses tangentially out of these openings creating a highly turbulent pair of oppositely rotating vortices which initially cools the wall of the chamber and meet adjacent the atomized liquid ejected from assembly 16.

The schematic diagram of FIG. 4 is illustrative of another embodiment of the invention wherein there are two atomizing assemblies 70 and 72 each of which are supplied with a primary source of air for initial atomization of the liquid. At least a pair of baffle assembles 74 and 76 are included to produce a total of four counterrotating vortices of secondary air at or near the impingement point of the liquid air mixture emanating from all of the atomizing apparatuses as heretofore described. Again radial slots 80 and 82 may be provided to pneumatically partially close off the combustion zone downstream of the combustible mass to confine the turbulent mixture.

Any number of primary atomizing devices could be used with a corresponding number of baffle assemblies to create multiple vortices which converge along the longitudinal axis of the fuel-air mixture thereby ensuring complete mixing of the combustible product. Therefore, there is a variety of combinations that could be employed while remaining within the boundaries of the present invention.

I claim:

1. In a fuel burner apparatus including one or more primary fuel atomizing means, an ignition means and a tubular housing extending from said atomizing means and forming an elongated combustion chamber, the improvement which comprises;

one or more longitudinal baffle means partially extending circumferentially around and spaced from the inner periphery of the housing,

means adjacent said baffle means for injecting air between said baffle means and the interior periphery of said housing, and

means to direct said air along the curved wall of said inner periphery of said housing inwardly into said combustion chamber in at least two oppositely directed streams from one of said partially extending baffle means, thereby forming at least a pair of impinging longitudinally extending, counterrotating vortices adjacent the axis of injection of atomized fuel from said primary fuel atomizing means into said combustion chamber.

2. The invention as set forth in claim 1 wherein said tubular housing contains a plurality of said baffle means each of which is convex in shape and are axially aligned about the inner periphery of said housing, the exterior edges of each of said baffles defining, with said periphery, axially aligned slots between the baffle and the housing so as to direct said air through said slots along the curved wall of said inner periphery inwardly of said combustion chamber forming a plurality of counterrotating vortices.

3. The invention as set forth in claim 1 wherein each of said baffle means includes means forming a radially oriented extended slot therein adjacent the end of said baffle means opposite said atomizing means, said slot directing a portion of said air radially across the end of said combustion chamber forming a pneumatic restriction partially confining combustion products within said combustion chamber to insure more uniform combustion.

4. The invention as set forth in claim 1 in which the baffle means comprises a concave baffle plate spaced from the interior wall of said housing thereby forming at least a pair of axially aligned slots adjacent the edges of said plate to direct said air along the curved wall of said inner periphery outwardly of said slots in opposite directions forming at least a pair of counterrotating vortices.

5. The invention as set forth in claim 4 wherein the concave wall forming the baffle plate converges with the wall of said housing to form a narrowed slot to accelerate the exiting air therefrom.

6. A fuel burner apparatus including one or more primary fuel atomizing means, an injection means and a tubular housing extending from said atomizing means forming an elongated combustion chamber comprising;

a plurality of longitudinal baffle means convex in shape partially extending circumferentially around and spaced from the inner periphery of the housing, and

means adjacent said baffle means for injecting air between said baffle means and the inner periphery of said housing, the exterior edges of each of said convex baffles defining with said inner periphery axially aligned slots between the baffle and the housing, said air being directed through said slots along the curved wall of said inner periphery inwardly of said combustion chamber in at least two oppositely directed streams from one of said convex baffles, forming a plurality of counterrotating vortices which impinge adjacent the axis of injection of atomized fuel from said primary fuel atomizing means into said combustion chamber.

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